REMEDIAL ACTION COMPLETION REPORT
DEBRIS, SLUDGE, AND MIXED-CONTAMINANT SOIL REMOVAL

Wildwood Property
Wells G & H Superfund Site
Woburn, MA

Prepared For:

BEATRICE COMPANY

Prepared By:

REMEDIATION TECHNOLOGIES, INC.
9 Pond Lane
Concord, MA 01742

RETEC Project No.: 3-0947-730

MARCH 1995

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

The Record of Decision (ROD) (U.S. EPA, 1989) and Consent Decree (U.S. EPA, 1991) for the Wildwood property identified five specific contaminated media which must be remediated on the property including:

- ***Debris*** - Soil, trash, rusted barrels, tires, wood, and miscellaneous debris.
- ***Sludge*** - Chemical residues, oily residues, asphalt spills, and dry cake-like asphalt-looking material.
- ***Mixed - Contaminant Soils*** - Soil contaminated with a combination of carcinogenic polynuclear aromatic hydrocarbons (cPAHs), polychlorinated biphenyls (PCBs), chlordane, 4-4-DDT, and lead.
- ***VOC - Contaminated Soils*** - Soil contaminated with volatile organic compounds (VOCs).
- ***Ground Water*** - Ground water contaminated with VOCs.

This report documents completion of the activities associated with the remediation of debris, sludge, and mixed-contaminant soil at the Wildwood property. It contains summaries of the investigations conducted to characterize the distribution of these media, characterization analytical results, excavation, transportation and disposal documentation, along with compliance sampling results taken upon completion of removal of these materials.

Section 1.0 is the introduction to this report. Section 2.0 describes the removal of debris. Sludge removal procedures are presented in Section 3.0 and mixed-contaminant soil removal is discussed in Section 4.0. Section 5.0 describes an investigation of soil containing barium. References are included in Section 6.0.

2.0 DEBRIS REMOVAL

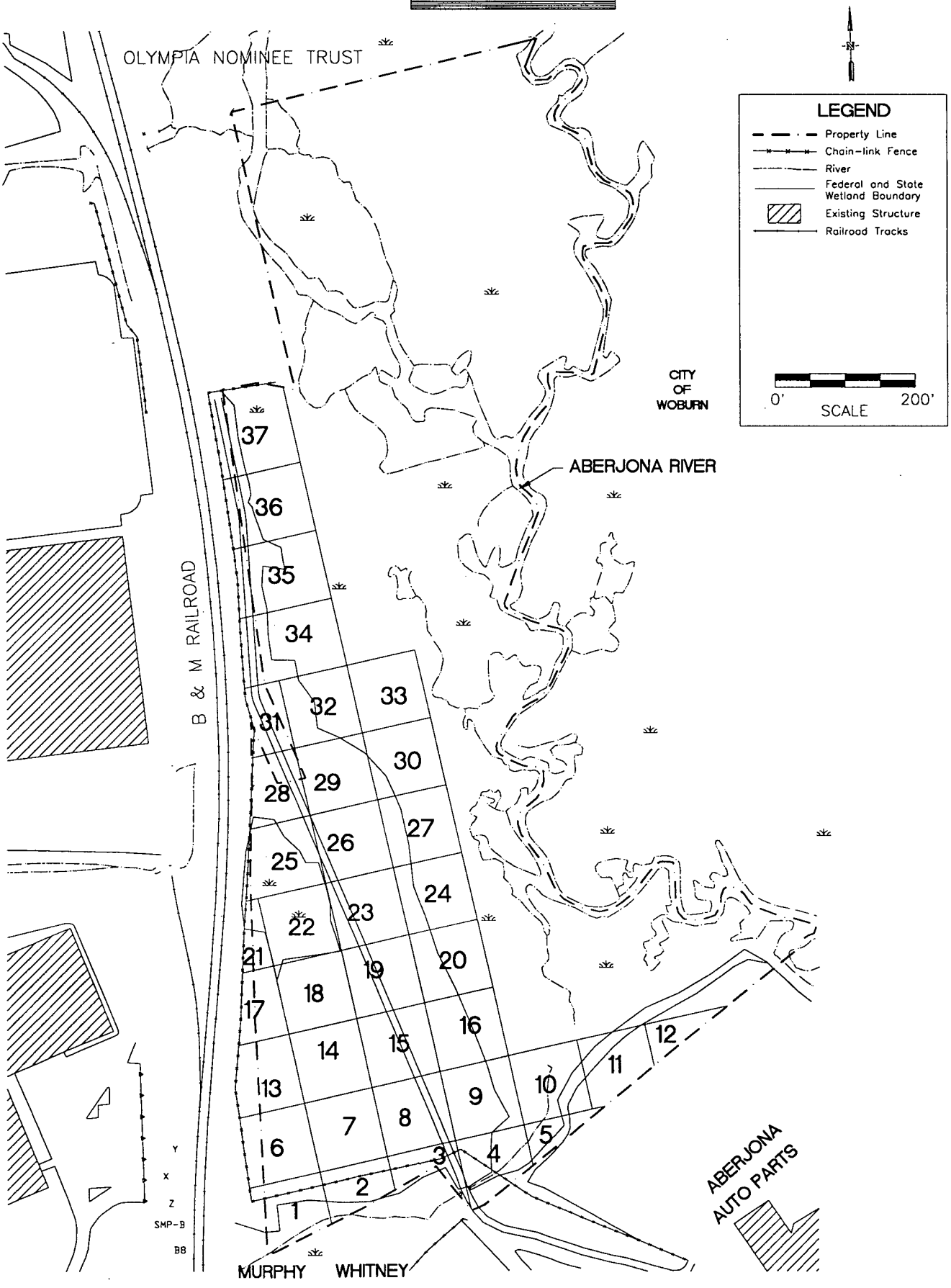
Reports from earlier investigations included information about the nature and extent of the debris at the Wildwood property. Descriptions of debris included:

- 55-gallon drums, barrel lids, lids from small pesticide containers, large amounts of municipal refuse, demolition debris, scrap iron, and miscellaneous debris (Massachusetts DEQE, 1980);
- empty oil tanks, several piles of 55-gallon drums and miscellaneous debris (Ecology & Environment, Inc., 1980); and
- rusted 55-gallon drums, debris piles, paint cans, trash (Alliance Technologies Corporation, 1986).

During a site inspection performed by Weston Geophysical, the debris was described as concrete, wood debris, scrap metal, broken TV sets, spring mattress, plastic, rusted car chassis, aluminum siding, rusted motor, barrel remains, metal debris, tires, pile of newspapers, old stairs, metal fencing, five-gallon bucket, quart-size oil cans, paint can, railroad ties, etc. (Weston Geophysical, 1986).

2.1 Debris Investigation

In order to determine disposal plans for the debris, more information was required regarding the location, extent, and estimated volume of each type of material. An investigation was conducted to systematically inventory all debris on the Wildwood property. The investigation included performing an inventory of 37 cells, 100 square-feet each, to catalog the debris (Figure 2-1). For the inventory, seven categories were used to classify debris as follows: metal, wood, construction debris, refuse, liquid waste, intact drums, and debris soil. Details of the investigation methods and findings were originally presented in the Predesign Investigation Report (RETEC, 1993) and are included in Appendix A. The results of the debris investigation were used to further characterize the debris and identify appropriate disposal facilities.



SITE GRID

FIGURE 2-1

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2.2 Consolidation

Debris consolidation activities were performed from December 1992 through January 1993. The debris was consolidated into groups according to the disposal facility selected for each type of debris. These categories were modified from the categories identified for the original workplan. The types of debris selected for consolidation were:

- construction debris,
- refuse,
- tires,
- drum carcasses,
- drum residues,
- soil within debris piles containing drums (Debris Soil B), and
- soil within debris piles not containing drums (Debris Soil A).

A description of consolidation activities for each type of debris is presented below.

Construction Debris

Large pieces of debris including scrap metal, wood, concrete, plastic, and other materials were classified as construction debris. The construction debris was moved to the on-site decontamination facility, decontaminated by brushing and pressure washing, inspected to ensure no soil or visible contamination remained and placed in rolloff boxes. A total of four rolloff boxes containing 30 cubic yards (cyd) each were filled with construction debris.

Refuse

Refuse, including paper, plastic, bottles, and cans were picked up from each grid established for the debris inventory. These materials were decontaminated by brushing and washing, placed in trash bags, and put in a six-cyd dumpster. The total volume of refuse was three cyd.

Tires

A separate six-cyd dumpster was used to consolidate old tires. Approximately 20 tires were found scattered around the site. The tires were brought to the on-site decontamination

facility, decontaminated by brushing and washing, inspected to ensure no soil or visible contamination remained, and placed into the dumpster.

Drum Carcasses

Drums in varying degrees of disintegration were inventoried and labeled. The identification number given to each drum indicated the debris inventory grid cell number and drum number. For example, "25-3" denotes cell 25, drum number three. The cell locations and number of drums found in each cell are presented in Appendix A. After removing the residues the empty drums were placed in a roll-off box.

Drum Residues

The contents of the drum carcasses were removed and consolidated in accordance with the results of drum residue characterization. Drum residue characterization is presented in Section 2.3. The residues were consolidated into the following six groups.

Group A Beige to white powder with the consistency of free flowing powder, adhering powder or caked crystals.

Group B Translucent, uncolored to opaque brown and black grease or petroleum gel mixed with debris.

Group C Soil and decomposed leaves which had accumulated in drums.

Group D Red-brown clay, mixed with resin.

Group E Variegated pigments and rubber with dry plaster, refuse and leaves.

Group F #2 fuel oil and water.

The residues from 44 drum carcasses were consolidated into 24 drums. The 24 drums of consolidated residues were moved to the on-site drum storage facility prior to off-site disposal. The emptied drums were handled as drum carcasses.

Debris Soil A

Debris soil consolidation was performed after construction debris, trash, and tires were removed from the debris piles. Soil from debris piles intermixed with small pieces of debris was placed into 30-cyd rolloff boxes. These soils were classified as Debris Soil A. A total of thirteen roll-offs were filled with twenty cyds each. Debris Soil A was consolidated from Debris Piles 1, 2, 3, 4, 5, 8, 10, 11, and 15. Appendix A contains a debris pile location map depicting the location of the debris piles.

During construction of site facilities discolored soil and sludge was excavated and stockpiled. This material was consolidated with Debris Soil A to avoid stockpiling the sludge until the sludge removal activities commenced. The following soil and sludges were added to Debris Soil A.

- 12 cyd black petroleum-based sludge and soil excavated from sludge locations SL-13, SL-14, and SL-19.
- 6 cyd yellow powder mixed with soil excavated from sludge locations SL-17, SL-18, and SL-21.
- Less than 1 cyd of Green sludge and soil excavated from sludge location SL-20.

Consolidation, characterization, and disposal of sludge is presented in Section 3.0.

Debris Soil B

The remaining soil within the debris piles containing drum carcasses was handled separately. This soil was classified as Debris Soil B. Debris Soil B was excavated concurrently with the mixed-contaminant soil. This material was processed through a screen and placed into a stockpile with the mixed-contaminant soil. Mixed-contaminant soil is discussed in Section 4.0. The volumes of Debris Soil B removed from each debris pile is summarized in Table 2-1.

TABLE 2-1
Debris Soil B
Excavation Summary

Original Location	Volume Excavated	Date Excavated
Debris Pile 1	20 cyd	9/30/94
Debris Pile 2	10 cyd	9/30/94
Debris Pile 3	10 cyd	9/30/94
Debris Pile 4	5 cyd	9/30/94
Debris Pile 5	30 cyd[1]	9/30/94
Debris Pile 5	60 cyd	11/17/94
Debris Pile 7	5 cyd[1]	9/30/94
Debris Pile 7	20 cyd	11/4/94
Debris Pile 15	10 cyd [1]	9/30/94
Debris Pile 15	15 cyd[2]	11/4/94
Debris Pile 15	15 cyd	12/15/94
Debris Pile G	20 cyd [3]	11/7/94

(1) Compliance samples collected at Debris Piles 5, 7, and 15 exceeded cleanup criteria for mixed-contaminant soil and were re-excavated.

(2) The second compliance sample collected at Debris Pile 15 exceeded clean up criteria for mixed-contaminant soils and was re-excavated.

(3) The first compliance sample for Debris Pile G was taken prior to removing any soil and exceeded cleanup criteria for mixed-contaminant soil.

2.3 Characterization

Construction Debris/Trash/Tires

Construction debris, refuse, and tires were characterized by visual identification. Visible criteria was specified for decontamination therefore no sampling was performed in the field.

Drum Carcasses

Residues were removed from each of the decaying drum carcasses. The emptied drum carcasses were transferred to a rolloff box located adjacent to the drum storage facility. The emptied drums were characterized as empty under the provisions of RCRA (less than one inch of residue remaining) and handled as a non-hazardous waste.

Drum Residues

Residues found in the drum carcasses were sampled to determine appropriate handling and disposal methods. The residues were characterized as follows.

Group A	Four drums of solid, non-hazardous waste.
Group B	Seven drums of liquid hazardous waste, exhibiting the toxicity characteristic (TC) for chlordane.
Group C	Four drums of solid hazardous waste, exhibiting the TC for chlordane.
Group D	Three drums of solid hazardous waste, exhibiting the TC for cadmium.
Group E	Four drums of non-hazardous liquid waste.
Group F	Two drums of liquid hazardous waste, exhibiting the TC for benzene.

The analytical results for the drum residues and the waste characterization reports are presented in Appendix B.

Debris Soil A

The consolidated soil was sampled in order to profile the material for disposal. The soil was grouped for sampling as follows:

Group A Roll-offs 1, 2, 3, 4, 5 containing debris soil from Debris Piles 1, 2, 3, 4, 5, and 15.

Group B Roll-offs 6, 7, 8, 9, 10, 11 containing debris soil from Debris Piles 3, 4, 5, 8, 10 and 11.

Group C Rolloff 12 containing debris soil from Debris Pile 1.

Group D Rolloff 13 containing debris soil from debris piles with yellow powder and drummed debris soil with green sludge from sludge locations 17, 18, 20 and 21.

Group E 12 cyds of debris soil mixed with black sludge from sludge locations SL-13, SL-14, and SL-19.

One composite sample was taken from each of the five groups. Aliquot samples were taken using a post hole digger and hand auger. The aliquots were analyzed for moisture content, ash content, BTU content, grain-size distribution, total petroleum hydrocarbons, total halogens, EP toxicity (copper and lead), corrosivity, reactivity, ignitability, toxicity characteristics, and PCBs. The samples were found to be non-hazardous. The characterization analytical results are summarized in Table 2-2. The sampling program for Debris Soil A in addition to the waste profile sheets, and analytical results are presented in Appendix C.

Debris Soil B

In August 1993 the remaining unsampled debris piles were characterized. Samples were collected from Debris Piles 6, 7, 9, 13, and 15. Composite samples were collected directly into 8-once jars using a hand trowel. Four aliquots within each debris pile made up the composite sample. The composite sample was analyzed for moisture content, ash content, BTU content, grain-size distribution, corrosivity, reactivity, ignitability, toxicity characteristics, and PCBs. Debris Soil B was found to be non-hazardous. The sampling programs for debris soil, waste profile sheets, and analytical results are provided in Appendix C.

Table 2-2
Debris Soil Characterization Sample Results
Wildwood Property
Wells G & H Superfund Site

Debris Soil Group	Estimated Volume (cyd)	Reactivity		Corrosivity	Ignitability	TPH	Total Halogens	EPA 8080 Pesticides	PCBs	Full TCLP	BTU Content	Ash Content	Moisture Content	Grain Size
		Sulfide (mg/Kg)	Cyanide (mg/Kg)	pH	(Deg F)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(Pass/Fail)	(BTU/lb)	(%)	(%)	
Debris Soil A	450													
Group A		< 1	< 0.3	5.0	> 200	94	< 0.01	90	ND	Pass	< 500	66	26	See Report
Group B		< 1	< 0.3	7.6	> 200	112	< 0.01	NR	ND	Pass	521	75	19	See Report
Group C		< 1	< 0.3	7.1	> 200	309	0.03	NR	25	Pass	596	71	23	See Report
Group D		1.1	< 0.3	5.8	> 200	700	0.45	NR	ND	Pass	767	82	14	See Report
Group E		1.9	< 0.3	4.8	> 200	156	< 0.01	NR	ND	Pass	777	67	23	See Report
Debris Soil B		< 1	< 0.3	5.0	> 200	NA	NA	12.8	16	Pass	1850	71	18	See Report

Notes:

The only pesticide detected in Group A was chlordane.

NR - Pesticides were not reported as part of EPA 8080 analysis, however chlordane was detected in the samples at the following concentrations:

Group B:	60 mg/kg
Group C:	46 mg/kg
Group D:	0.84 mg/kg
Group E:	1.1 mg/kg

NA - Not analyzed

2.4 Transportation and Disposal

Construction Debris

In July, 1993 all four rolloff boxes containing construction debris were sent to Northern Disposal Landfill, 234 Thatcher Street, East Bridgewater, Massachusetts. Browning-Ferris Industries (BFI) transported the waste under a non-hazardous special waste manifest. A copy of the waste profile sheet is included in Appendix D.

Refuse

The three cyds of refuse were transported by BFI to a solid waste incinerator. The incinerator is located in Haverhill, Massachusetts, and is run by BFI.

Tires

The tires were transported by BFI to a stockpile at BFI's transfer station, 29 East Street, Cambridge, Massachusetts. The ultimate disposal facility was determined by BFI.

Drum Carcasses

The drum carcasses were transported by Jeffrey Chemical Company to the Wayne Disposal Inc. hazardous waste landfill located in Belleville, Michigan. Although the drum carcasses were characterized as non-hazardous, they were disposed of in a hazardous waste landfill to ensure the safest disposal option. A copy of the hazardous waste manifest and certificate of disposal is included in Appendix D.

Drum Residues

The twenty-four drums of consolidated residues were transported in December 1993 by Freehold Cartage Inc. for disposal at Envotech Management Services, Inc., of Belleville, Michigan. All twenty-four drums were transported under a hazardous waste manifest. Copies of the manifests and certificates of disposal are included in Appendix E.

Debris Soil A

Debris Soil A was transferred into eighteen roll-offs for ease of transporting. This step was performed to meet weight restrictions for transporting the rolloff boxes over public roads.

In April 1994, transportation and disposal of the eighteen rolloff boxes containing Debris Soil A was completed. Trucks and rolloff boxes were inspected for any visual contamination prior to leaving the site. Debris Soil A was disposed of at the Browning Ferris Industries (BFI) Mahoning Landfill in Lowellville, Ohio. The shipments were transported under a non-hazardous special waste manifest. A shipping summary table and copies of the manifests are located in Appendix F.

Debris Soil B

Transportation services were performed by Franklin Environmental Services Inc., of Wrentham, Massachusetts. Debris Soil B was consolidated with the mixed-contaminant soil and transported to Giant Resource Recovery, Inc. (Giant), of Harleyville, South Carolina beginning October 4, 1994. Eighty dump trailer trucks carrying a total of 1,810.23 tons of soil were sent to Giant. Trucks were decontaminated and inspected for any visual contamination prior to leaving the site. The soil was transported as a non-hazardous waste. The soil was incinerated in a cement kiln and recycled as cement. A shipping summary table and certificates of disposal are included in Appendix J.

2.5 Compliance Sampling

Compliance samples were collected from eight debris pile locations, as specified in the Predesign Work Plan (RETEC, 1992) on October 5, November 15, and December 15, 1994. The debris pile compliance sampling results are summarized in Table 2-3. CLP data packages are included in Appendix V.

Composite samples were collected directly into 8-ounce jars using a hand trowel. Five aliquots within the footprint of each former debris pile made up each composite sample. These five aliquots were collected from the center and four corners of each excavation. All five locations were flagged and the center location was surveyed. This information was used to create Figure 2-2 which shows the extent of the debris pile excavations and compliance sample locations.

The compliance samples were analyzed for lead, chlordane, 4-4-DDT, cPAHs, and PCBs. The results of the compliance sampling indicated the soil beneath four debris piles was above cleanup criteria. The footprint of these four former debris piles were re-excavated six inches deeper than resampled. The results of the second round of compliance samples indicated three

TABLE 2-3
Debris Pile (mg/Kg)
Compliance Sample Summary

Compound	Target Concentration	DP-1 10/05/94	DP-3 10/05/94	DP-5 10/05/94	DP-5 11/15/94	DP-6 10/05/94	DP-7 10/05/94	DP-7 11/15/94
Lead	640	37.5	45.1	84.3	--	--	--	--
Chlordane	6.14	0.181	0.053	34.67	3.899	0.004	0.041	0.005
4, 4 - DDT	23.5	0.008	0.012	0.874	0.208	0.001	0.005	0.005
cPAHs	0.69	0.280	0.252	0.252	--	0.266	0.986	0.294
PCBs	1.04	0.637	0.075	329.2	0.318	0.291	1.788	0.369
STATUS		pass	pass	fail	pass	pass	fail	pass

Compound	Target Concentration	DP-10 10/05/94	DP-15 10/05/94	DP-15 11/15/94	DP-15 12/15/94	DP-G 10/05/94	DP-G 11/15/94
Lead	640	--	174	--	--	130	--
Chlordane	6.14	0.139	0.800	3.111	--	0.008	--
4, 4 - DDT	23.5	0.063	0.305	0.854	--	0.018	--
cPAHs	0.69	0.150	0.142	--	--	2.758	0.037
PCBs	1.04	0.960	6.540	19.141	0.227	0.415	--
STATUS		pass	fail	fail	pass	fail	pass

Notes:

All concentrations mg/kg

-- No analysis performed

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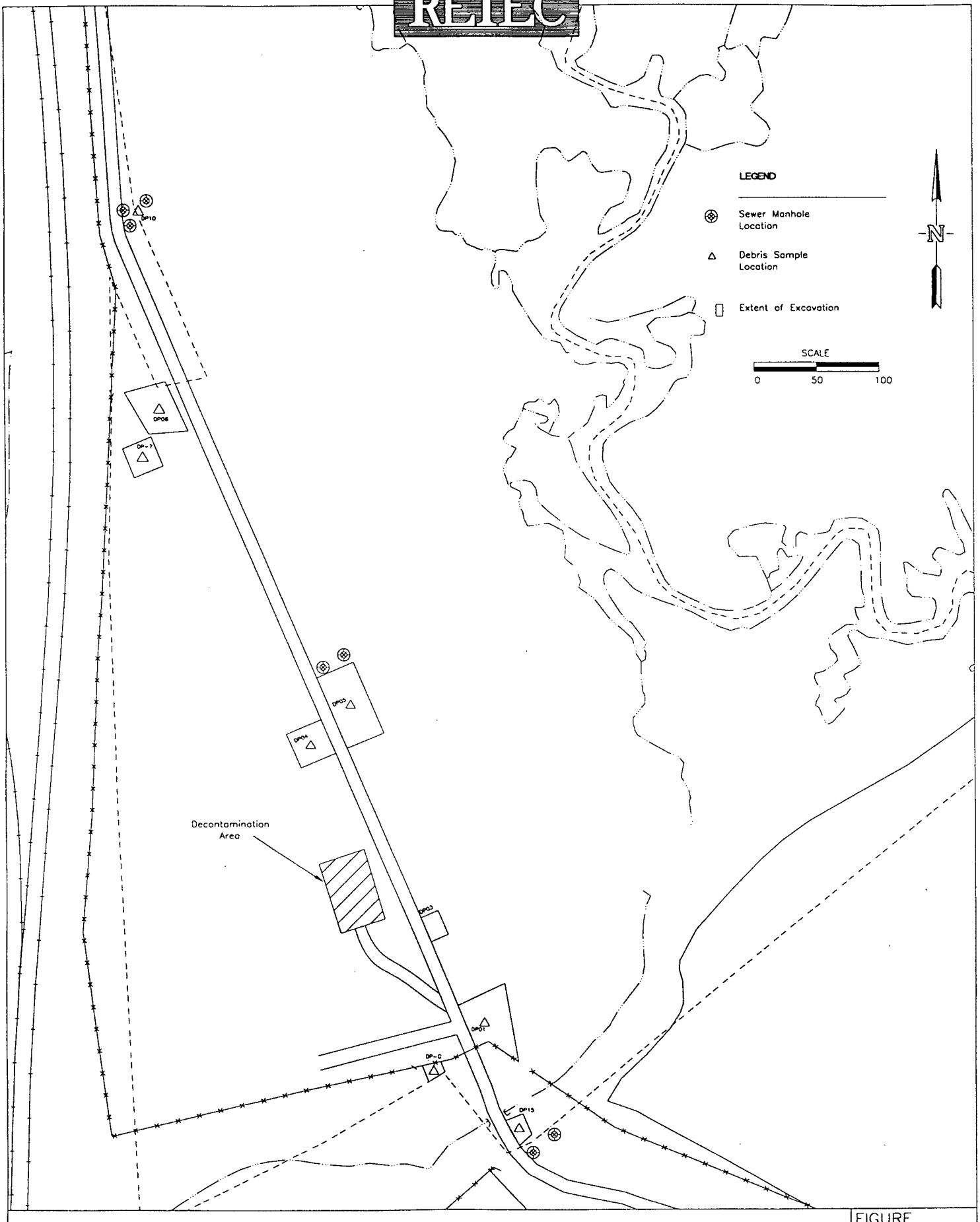

DEBRIS PILE EXCAVATIONS

FIGURE
2-2
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of the four debris piles achieved cleanup standards. After re-excavating an additional six inches and resampling Debris Pile 15 for the third time it achieved cleanup standards.

All debris pile compliance samples were analyzed for the VOCs identified in the ROD as having a soil cleanup level. This information will be an aid in delineating the areas of VOC contamination. Debris Pile 7 was the only location which exceeded the ROD soil cleanup for VOCs. This former debris pile location exceeded the cleanup level for trichloroethene.

Twenty percent of all debris pile compliance samples were analyzed for the full target analyte list (TAL) and target compound list (TCL). All debris pile compliance sample results are summarized in Appendix G.

3.0 SLUDGE REMOVAL

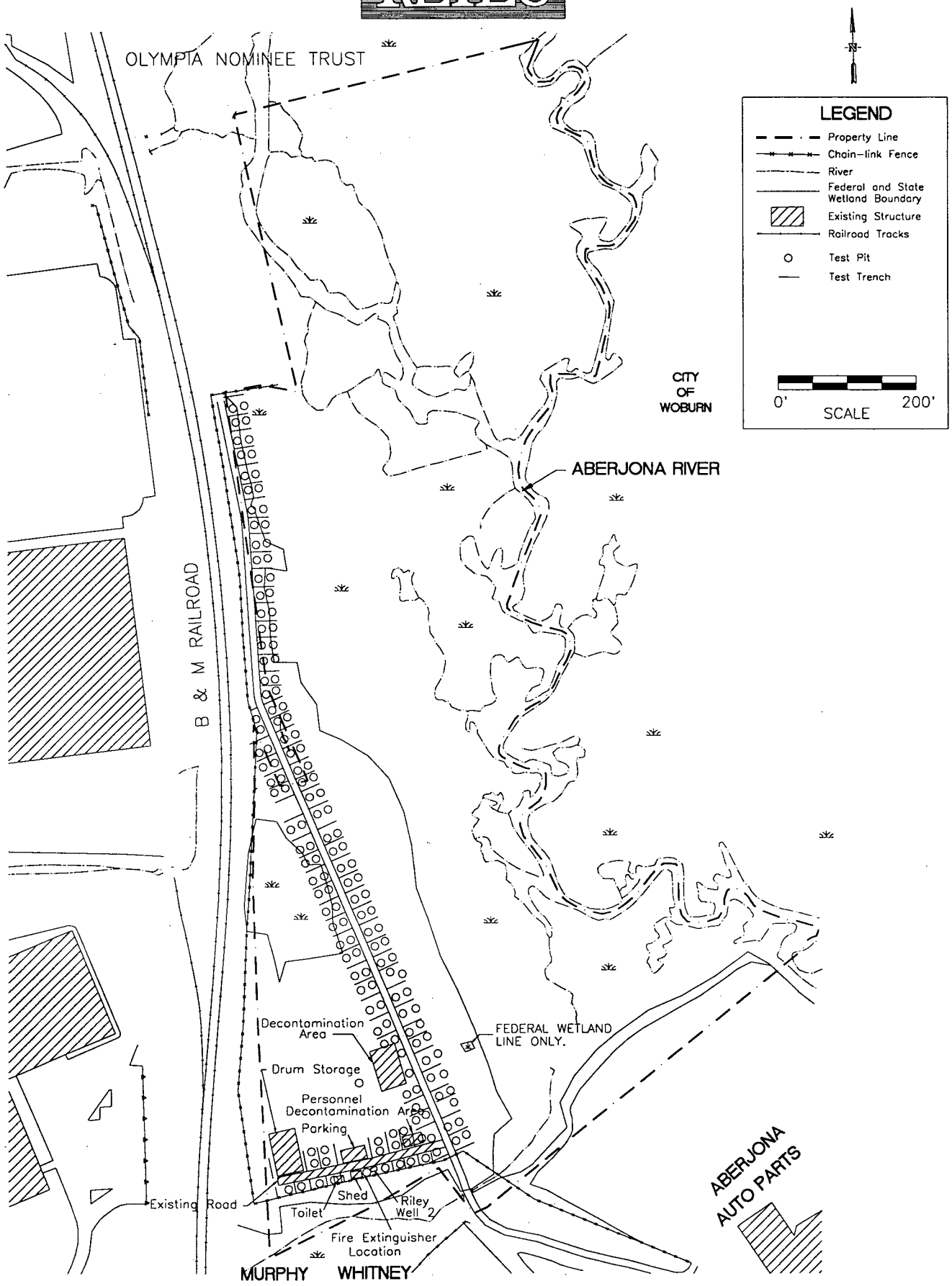
The RI/FS identified materials designated as "sludges" on the Wildwood property. Reports from previous investigations also presented information about the nature and extent of sludge locations identified at the site. Earlier reports indicated that sludges appeared to have been placed on site over a period of years, although no specific source was identified. Descriptions of material described as sludges from previous reports include the following:

- chemical residues; oily residue (Massachusetts DEQE, 1980);
- asphalt spills (Ecology & Environment, Inc., 1980);
- discolored soil; tarry sludge (Alliance Technologies Corporation, 1986);
- black, brown sludge; tar; tarry sludge; discolored soil (Weston Geophysical Corp., 1986); and
- a dry cake-like asphalt-like material; an oily, petroleum-like, moist material (Clement Associates, 1988).

During site infrastructure construction in August 1992, and during sludge consolidation activities, sludge was found which was not identified in previous site investigations. As a result of these discoveries, a detailed and systematic investigation was performed to fully delineate all sludge on the Wildwood property.

3.1 Sludge Investigation

The supplemental investigation began in November 1992. Shallow test trenches were excavated perpendicular to the access road every 25 feet. The test trenches were 25 feet long. Two test pits, three to six feet long, were excavated in the intervals between each trench. The locations of the excavations are shown in Figure 3-1. The results of the investigation are summarized in Table 3-1 and Figure 3-2. Details of the investigation methods and findings were originally presented in the Predesign Investigation Report and are excerpted in Appendix H.



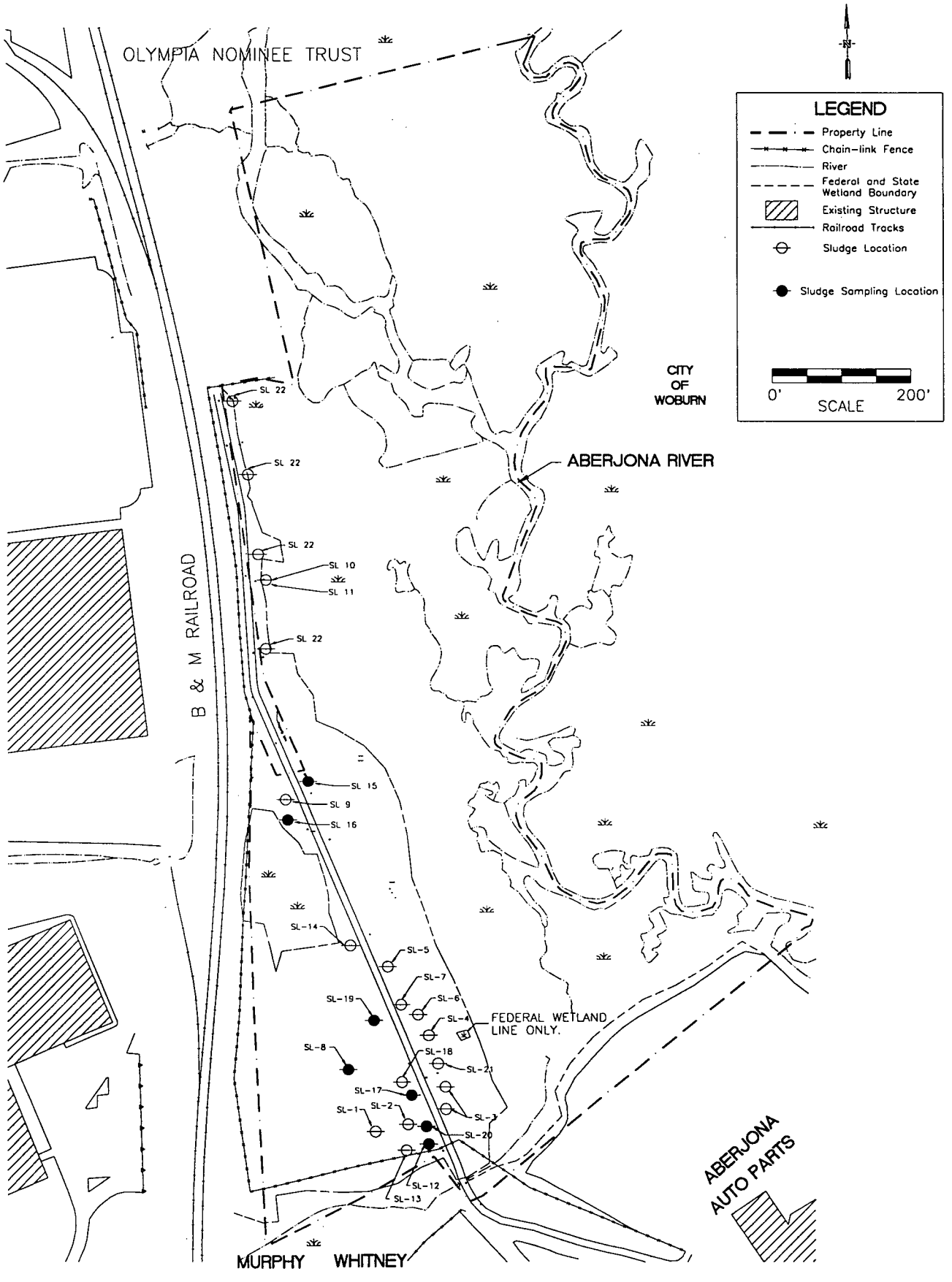
SUPPLEMENTAL SLUDGE INVESTIGATION LOCATIONS

FIGURE 3-1

WILDW3

TABLE 3-1
Sludge Characterization Summary
Wildwood Property, Wells G & H Superfund Site

Physical Description	I.D. Number	Volume (Cubic Yards)	Percent Organic	Primary Constituents	Characterization
Black Viscous Sludge	SL-1	0.2		Chlordane PAHs	Petroleum Residue
Black Viscous Sludge	SL-2	6		Bis (2-Ethylhexyl) Phthalate 4,4-DDT	Petroleum Residue
Black Viscous Sludge	SL-10/11	8		PAHs	Petroleum Residue
Black Viscous Sludge	SL-13	11		Not analyzed	Petroleum Residue
Black Viscous Sludge	SL-14	11		Not analyzed	Petroleum Residue
Black Viscous Sludge	SL-19	9		Not analyzed	Petroleum Residue
Black Crusty Sludge	SL-3	43		Bis (2-Ethylhexyl) Phthalate PAHs	Petroleum Residue
Black Crusty Sludge	SL-4	0.1		Bis (2-Ethylhexyl) Phthalate	Petroleum Residue
Black Crusty Sludge	SL-5	19.0		No VOC or mixed constituents of concern above cleanup criteria	Petroleum Residue
Black Crusty Sludge	SL-6/7	37		Pyrene Benzo(a)pyrene Toluene	Petroleum Residue
Black Crusty Sludge	SL-8	2.4		4,4-DDT Bis (2-Ethylhexyl) Phthalate Pentachlorophenol Tetrachloroethene	Petroleum Residue
Black Crusty Sludge	SL-9	3		Chlordane Benzoil Acid Xylenes Bis (2-Ethylhexyl) Phthalate Phenol Ethylbenzene	Petroleum Residue
Black Crusty Sludge	SL-15	12.0	25%	Asphaltic/Polymeric Resin	Petroleum Residue
Grey-White Powder	SL-22	Not estimated		Barium Sulfide	Barium Sulfide
Yellow Powder	SL-17	4.0	<1%	Lead, Chromium	Paint Pigment
Yellow Powder	SL-18	1.0		Not analyzed	Paint Pigment
Yellow Powder	SL-21	0.1		Not analyzed	Paint Pigment
Green Sludge	SL-20	3.0	97%	Alkyd Polymers	Paint Residue
Turquoise Brittle Solid	SL-15	1.0	24%	Aromatic Esters	Dye or Pigment
Yellowish-White Gel	SL-8	0.5	100%	Petroleum Hydrocarbons	Petroleum Grease
Blue Solid	SL-21	0.1		Not analyzed	Unknown
Brown Hard Plastic	SL-16	4	34%	Polyvinyl Polymer	Pigmented Plastic
Light Brown Cellulose	SL-12	17	100%	Cellulose	Waste Filter Media



REVISED SLUDGE LOCATION MAP

FIGURE 3-2

WILDW3.DWG

3.2 Sludge Characterization

Sludge characterization sampling was performed in May 1993. The sludge was sampled to determine an appropriate disposal facility. The sludge was grouped for sampling as follows:

Group F Black Viscous Sludge; including sludges from locations SL-1, SL-2, SL-10/11, SL-12, SL-13, SL-14, and a drum of sludge consolidated during the predesign investigation in November 1992 from locations SL-1, SL-2, SL-4, SL-5 and SL-8.

Group G Black Crusty Sludge; including sludge from locations SL-3, SL-4, SL-5, SL-6, SL-7 and SL-15.

Group H All Remaining Sludge; including , SL-8, SL-9, SL-12, SL-15 SL-16 and SL-21.

The estimated volume of sludge was 155 cubic yards (cyds) of non-hazardous sludge (Groups G and H) and 50 cyds of TC hazardous sludge (Group F). The sludge from Group F exhibited the hazardous characteristics of lead and chlordane. The sludge characterization sampling results are summarized in Table 3-2. A complete description of the sludge characterization sampling, analytical results, and waste profile sheets can be found Appendix I.

3.3 Sludge Excavation

Littleton Environmental Services, Inc. of Littleton, Massachusetts performed the excavation work. Site work began on August 23, 1994. The sludge locations were flagged and cleared of trees and brush. The access road and decontamination pad were improved to allow access by large trucks and excavation equipment. Several loads of crushed stone were imported to improve the road and build a turnaround area for trucks. The source of the crushed stone was Benevento Sand & Gravel Co. of North Wilmington, Massachusetts.

Sludge excavation began on August 25, 1994. The estimated volumes removed from each sludge location are summarized in Table 3-3.

Sludge was also encountered during excavation of debris piles. Although the material in debris piles was characterized as non-hazardous (refer to Section 2.3), sludges removed

Table 3-2

Sludge Characterization Sample Results

Wildwood Property

Wells G & H Superfund Site

Sludge Group	Estimated Volume (cyd)	Reactivity		Corrosivity	Ignitability	TPH	Total Halogens	Pesticidies[1]	PCBs	Full TCLP	BTU Content	Ash Content	Moisture Content	Grain Size
		Sulfide (mg/Kg)	Cyanide (mg/Kg)	pH	(Deg F)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(Pass/Fail)	(BTU/lb)	(%)	(%)	
Group F	50	<1	<0.3	5.3	>200	24,300	586	9,900	ND	Fail[2]	7,300	26	7	See Report
Group G	125	<1	<0.3	5.8	>200	9,000	346	642	ND	Pass[3]	2,980	82	5	See Report
Group H	30	<1	<0.3	6.6	>200	22,700	952	2,310	ND	Pass	6,240	58	16	See Report

Notes:

1 - Chlordane was the only pesticide detected.

2 - Failed for Lead (23 mg/kg limit of 5.0) and Chlordane (0.11 mg/kg limit of 0.03). Had concentrations of Barium (1.7 mg/kg) in TCLP.

3 - Had concentrations of Lead (1.3 mg/kg, Tetrachloroethylene (0.51 mg/kg), and Trichloroethylene (0.08 mg/kg) in TCLP.

4 - Had concentrations of Cadium (0.12 mg/kg), Chromium (0.25 mg/kg), Lead (2.9 mg/kg), Benzene (0.03 mg/kg) and Chlordane (0.02 mg/kg) in TCLP.

TABLE 3-3

Sludge Excavation Summary

Sludge Location	Volume (cyd)	TC Hazardous	Date Excavated
SL-01	1	yes	8/25/94
SL-02	15	yes	9/30/94
SL-03	10	no	8/26/94
SL-04	6	no	8/26/94
SL-05	6	no	8/26/94
SL-06/07	44	no	8/26/94
SL-08	3[1]	no	8/25/94
SL-08	2	no	9/7/94
SL-09	5	no	8/29/94
SL-10/11	10[1]	yes	8/29/94
SL-10/11	3	yes	9/7/94
SL-12	4[1]	no	8/25/94
SL-12	18	no	9/8/94
SL-13	9	yes	8/25/94
SL-14	14[1]	yes	8/26/94
SL-14	5	yes	9/7/94
SL-15	20	no	8/29/94
SL-16	5	no	8/29/94
SL-17/18	10	yes	10/18/94
SL-19, 20, and 21[2]		no	
DP-4	1	yes	8/26/94
West of DP-10	1	yes	11/7/94
DP-1	30	no	9/7/94
DP-5	5	no	8/26/94
DP-6	10	no	8/29/94
DP-7	15	no	8/29/94

1. After receiving the results from the first round of compliance sampling some sludge areas were re-excavated. Sludge locations SL-8, 12, and 14 failed compliance and were re-excavated. The compliance sample result for SL-10/11 was close to the cleanup level but passed. This area was re-excavated to ensure the sludges were removed.
2. Sludge locations SL-19, 20, and 21 were the sludges discovered during infrastructure construction, in August 1992. These sludge locations were completely excavated and disposed of with debris soil "A".

from debris piles that were similar in appearance to hazardous sludges were handled as hazardous sludge to ensure that the material was treated appropriately. One cyd of brown pliable sludge was removed from Debris Pile 4 and stockpiled with the hazardous sludge. A black viscous sludge was found on the west side of the access road adjacent to Debris Pile 10. One cyd of the black viscous material was excavated from this location and disposed of with the hazardous sludge.

Personal protective equipment (PPE) and tree stumps generated during sludge removal were disposed of with the hazardous sludge. Three liquid-phase carbon treatment drums from the on-site water treatment system, and all sludge and PPE generated during the supplemental sludge investigation, stored in the drum storage facility were disposed of with the hazardous sludge.

Sludge found in debris piles that had the appearance of non-hazardous sludges and were adjacent to non-hazardous sludges, were handled as non-hazardous sludge. Debris Pile 5 located adjacent to sludge location SL-05 contained black crusty sludge. Approximately five cyds of this material was removed and handled as non-hazardous sludge. Debris Pile 1 contained significant amounts of the sludge found at sludge location SL-03 (Debris Pile 1 is adjacent to SL-03). Thirty cyds of this sludge was excavated and handled as non-hazardous sludge. All of this material is included in Table 3-3. All non-contaminated trash, (i.e. cardboard boxes, packing materials) was disposed of with the non-hazardous sludge. Prior to demobilization equipment it was decontaminated and inspected to ensure no visible contamination remained.

3.4 Sludge Transportation and Disposal

Franklin Environmental Services, Inc. of Wrentham, Massachusetts transported both the hazardous and non-hazardous sludges. Eighteen-wheeled dump trailers were used. All trucks were decontaminated and visually inspected for contamination prior to leaving the site.

Three trucks transported a total of 66.54 tons of TC hazardous sludge to the Envirosafe Services Landfill in Oregon, Ohio. Copies of the certificates of disposal, hazardous waste manifests, and the Ohio Land Disposal Restriction Form are included in Appendix L.

Sixteen trucks transported a total of 354 tons of non-hazardous sludge to the Browning-Ferris Industries Mahoning Landfill located in Lowellville, Ohio. Copies of the non-hazardous waste bills of lading are included in Appendix J.

3.5 Sludge Compliance Sampling

Compliance samples were collected from fifteen locations on August 30, September 8, and October 18, 1994 in accordance with the letter from RETEC to EPA dated August 9, 1994. The analytical results of the sampled sludge areas are summarized in Table 3-4. CLP data packages are included in Appendix V.

Composite samples were collected directly into 8-ounce jars using a hand trowel. Five aliquots within each sludge location made up each composite sample. These five aliquots were collected from the center and four corners of each excavation. All five locations were flagged and the center location was surveyed. This information was used to create Figure 3-3 which shows the extent of the sludge excavations and compliance sample locations.

The compliance samples were analyzed for lead, chlordane, 4-4-DDT, cPAHs, PCBs, and VOCs. The results of the compliance sampling indicated that soil beneath three sludge locations were above cleanup criteria. The footprint of these three former sludge locations were re-excavated six inches deeper and resampled. The results from the second round of compliance samples indicated these three areas achieved cleanup standards. A summary of the sludge compliance samples is presented in Table 3-4.

All sludge compliance samples were analyzed for the VOCs identified in the ROD as having a soil cleanup level. This information will be an aid in delineating the areas of VOC contamination. Sludge locations SL-10/11 and SL-15 were the only two sludge locations which exceeded the ROD soil cleanup level for VOCs. Both locations exceeded the cleanup level for trichloroethene.

Twenty percent of all sludge compliance samples were analyzed for the full target analyte list (TAL) and target compound list (TCL). All sludge compliance sampling results are summarized in Appendix K.

3.6 Sludge Location Restoration

All excavated sludge locations were backfilled and reseeded. Sludge location SL-03 was the only excavation greater than one foot deep. This excavation was backfilled with subsoil to one foot below the original grade. Then the remaining one foot was backfilled with a fine sandy loam

Table 3-4
Sludge Compliance Sample Summary (mg/Kg)

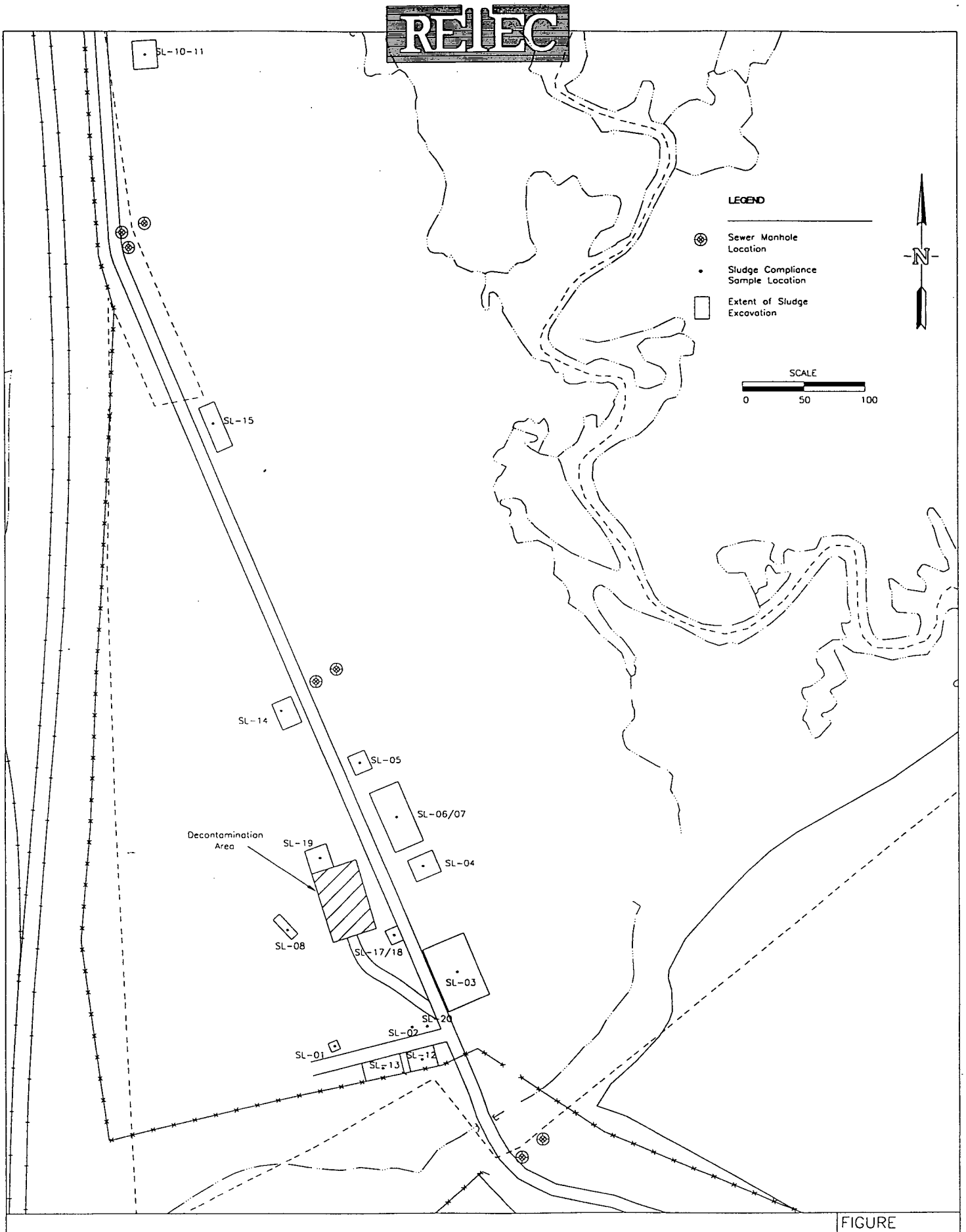
Compound	Target Concentration	SL-1 08/30/94	SL-2 10/18/94	SL-3 08/30/94	SL-4 08/30/94	SL-5 08/30/94	SL-6/7 08/30/94	SL-8 08/30/94	SL-8 09/08/94	SL-10/11 08/30/94
Lead	640	19.0	9.1	124.8	72.7	14.2	8.7	51.3	--	10.2
Chlordane	6.14	0.015	0.251	0.786	0.011	1.492	0.009	50.55	4.206	0.293
4, 4 - DDT	23.5	0.007	0.019	0.084	0.004	0.035	0.006	0.933	0.035	0.004
cPAHs	0.69	0.028	0.026	0.101	0.561	0.211	0.252	0.284	--	0.035
PCBs	1.04	0.297	0.334	0.979	0.259	0.263	0.274	307.1	0.290	0.346
STATUS		pass	pass	pass	pass	pass	pass	fail	pass	pass

Compound	Target Concentration	SL-12 08/30/94	SL-12 09/08/94	SL-13 08/30/94	SL-14 08/30/94	SL-14 09/08/94	SL-15 08/30/94	SL-17/18 10/18/94	SL-19 10/18/94	SL-20 10/18/94
Lead	640	228.5	--	66.6	58.1	--	24.2	41.9	29.5	41.0
Chlordane	6.14	0.283	--	0.010	0.049	--	0.020	0.021	0.010	1.490
4, 4 - DDT	23.5	0.179	--	0.006	0.032	--	0.002	0.002	0.004	0.004
cPAHs	0.69	1.930	0.302	0.320	0.323	--	0.124	0.259	0.257	0.341
PCBs	1.04	0.416	--	0.036	1.328	0.538	0.248	0.331	0.351	0.325
STATUS		fail	pass	pass	fail	pass	pass	pass	pass	pass

Notes:

All concentrations mg/kg

-- No analysis performed



SLUDGE EXCAVATIONS

FIGURE
3-3
0947s004

top soil. Backfill was visually inspected to ensure the material matched the specification. Sludge location SL-10/11 was the only area located within a wetland. This area was backfilled with a silt loam topsoil high in organic matter. Benevento Sand and Gravel Co., of North Wilmington, Massachusetts, supplied all subsoil backfill. Dexter and Harpell Loam Inc., of Acton, Massachusetts, supplied all topsoil backfill.

The subsoil and topsoil was compacted with a bulldozer. One foot lifts of soil were spread then compacted by the weight of the bulldozer. After spreading the topsoil, the excavation areas were reseeded. Reclamation seed mixture was spread using a hand spreader. The reclamation seed mixture consisted of the following seed types:

- 54.07 % Montauk Tall Fescue
- 14.73 % Warwick Hard Fescue
- 9.85 % Duet Perennial Ryegrass
- 9.76 % POA Trivials
- 4.91 % Reed Canarygrass
- 4.78 % Redtop
- 1.59 % Inert Matter
- 0.19 % Other Crop Seed
- 0.12 % Weed Seed

4.0 MIXED-CONTAMINANT SOIL REMOVAL

This section presents activities associated with the remediation of mixed-contaminant soil. Mixed-contaminant soil is defined in the ROD as soil containing VOCs, carcinogenic PAHs, PCBs, chlordane, 4-4-DDT, and lead above specified cleanup criteria. The clean-up criteria for these contaminants, are presented in Table 4-1. The results of the predesign investigation were used to delineate the extent of mixed-contaminant soils at the Wildwood property. On September 8, 1994, EPA approved the 100% Design Report for Mixed-Contaminant Soils (RETEC, 1994), which outlines the procedures used to excavate and transport mixed-contaminant soils and restore the excavation locations. The report described a compliance sampling program which was performed to document the successful removal of mixed-contaminant soils.

4.1 Investigation

The Predesign Work Plan for the Wildwood property (RETEC, 1992) identified data gaps related to the design of the remedies for soils containing mixed-contaminants. The work plan specified that existing data and data collected during the predesign investigation would be combined to prepare a new estimate of the limit of soils requiring remediation. During July and August 1992, soil samples were collected for this purpose. The limits of mixed-contaminant soils exceeding the cleanup criteria are depicted in Figure 4-1. The details of the investigation were originally presented in the Predesign Investigation Report (RETEC, 1993) and are excerpted in Appendix L.

In order to further define the limits of soils containing polychlorinated biphenyls (PCBs) that would be regulated under the Toxic Substance Control Act (TSCA), supplemental sampling was performed in October 1993. The result of this sampling is depicted in Figure 4-1 as the delineation of Areas 2A and 2B. These two areas were delineated as areas of soil containing PCBs greater than 50 mg/Kg. A sample location map and a summary of the analytical results are presented in Appendix M.

Area 4 was defined by a single sample exceeding mixed-contaminant soil cleanup criteria. Supplemental sampling was performed on August 12, 1994 to better define the limits of Area 4. The result of this sampling is depicted on Figure 4-2. The supplemental sampling analytical results are presented in Appendix N.

TABLE 4-1

Soil Contaminant Cleanup Goals

COMPOUND	BASIS	TARGET SOIL CONCENTRATION (mg/Kg)
Chloroform	L	0.137
Tetrachloroethene	L	0.080
Trichloroethene	L	0.071
trans-1,2-Dichloroethene	L	0.180
1,1,1-Trichloroethane	L	1.226
Chlordane	R	6.140
4,4-DDT	R	23.500
*ΣcPAHs	R	0.690
PCBs	R	1.040
Lead	B	640.0

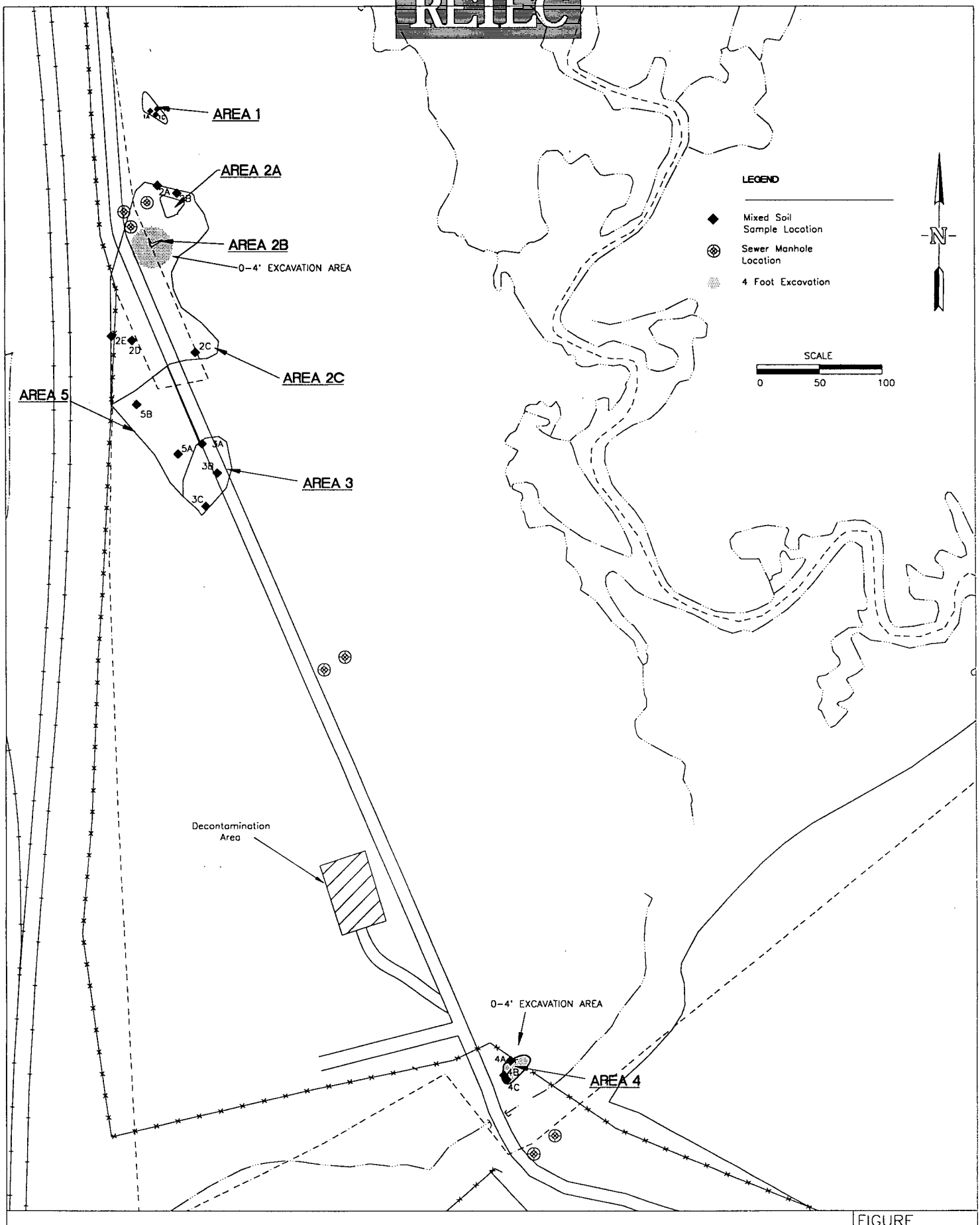
*The cPAHs are: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo (a) pyrene, chrysene, dibenzo (a,h) anthracene, and indeno (1,2,3-c,d) perylene. This level refers to the total of all cPAHs at any one location.

NOTES:

L = Indicated goal based on leaching model.

R = Indicated goal based on carcinogenic risk model.

B = Indicated goal based on blood levels.



AREAS OF MIXED CONTAMINANT SOIL

FIGURE
4-1
0947s004

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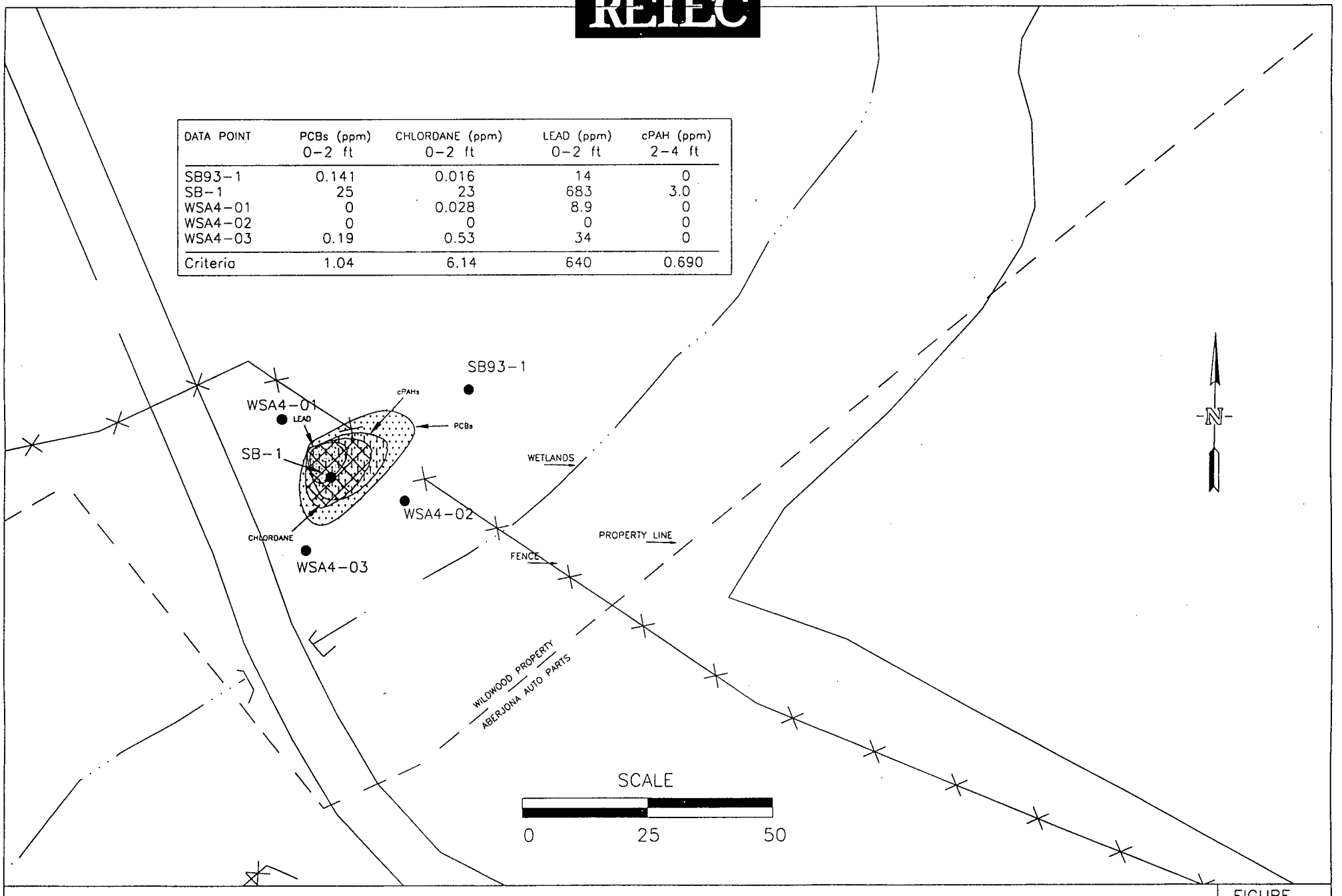
DATA POINT	PCBs (ppm) 0–2 ft	CHLORDANE (ppm) 0–2 ft	LEAD (ppm) 0–2 ft	cPAH (ppm) 2–4 ft
SB93–1	0.141	0.016	14	0
SB–1	25	23	683	3.0
WSA4–01	0	0.028	8.9	0
WSA4–02	0	0	0	0
WSA4–03	0.19	0.53	34	0
Criteria	1.04	6.14	640	0.690



Delineation of Area 4

FIGURE
4-2
0947S004

4.2 Characterization

In June 1993 prior to excavation activities, soil samples were collected for the purpose of characterizing the soil for disposal facilities. Details of the sampling methods, analytical results, and copies of the waste profile sheets sent to the disposal facilities are included in Appendix O.

The mixed-contaminant soil required three types of management. Soil impacted with PCBs greater than 50 mg/Kg was characterized as TSCA soil. Mixed-contaminant soil and soil from debris piles containing drums (Debris Soil B) was characterized as non-hazardous soil by RCRA. Tailings from screening the mixed-contaminant soil and stumps generated from clearing trees and vegetation from excavation areas was managed as debris. The tailings were characterized and disposed of as a hazardous waste. The mixed-contaminant soil characterization analytical results are summarized in Table 4-2.

4.3 Excavation

Littleton Environmental Services, Inc., of Littleton, Massachusetts, performed the excavation work. Site work began on September 9, 1994. The surveyed boundaries of mixed-contaminant soil and debris piles were cleared of all vegetation. All brush and small trees were chipped and left on site. Large trees were cut, stacked, and left on site. Erosion controls were set up in areas near or within wetlands.

Figure 4-1 shows each of the five excavation areas. Excavation began on September 21, 1994. Area 1 was excavated, screened, and placed in a plastic lined stockpile. Next, Areas 2A and 2B (PCBs greater than 50 mg/Kg) were excavated, screened, and stockpiled in a separate lined stockpile. Excavating, screening, and stockpiling continued until all areas of mixed-contaminant soils were excavated and stockpiled. The excavations were two feet deep except where depicted on Figure 4-1 as being four feet deep.

The soil in the remaining debris piles (Debris Soil B) was then excavated, screened, and stockpiled. The volumes of soil removed from the mixed-contaminant areas and debris piles are summarized in Table 4-3. Prior to demobilizing equipment was decontaminated and inspected for visual contamination.

Table 4-2
Mixed-Contaminant Soil Characterization Sample Results
Wildwood Property
Wells G & H Superfund Site

Debris Soil Group	Reactivity		Corrosivity	Ignitability	TPH	Total Halogens	Pesticides	PCBs	Full TCLP	BTU Content	Ash Content	Moisture Content	Grain Size
	Sulfide (mg/Kg)	Cyanide (mg/Kg)	pH	(Deg F)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(Pass/Fail)	(BTU/lb)	(%)	(%)	
Non-TSCA Soils													
Area 1	<1	<0.3	4.9	>200	40	<0.01	ND	0.93	Pass	<500	80	17	See Report
Area 2	<1	<0.3	5.2	>200	26	<0.01	ND	6.5	Pass	1,078	81.5	13.5	See Report
Area 3	<1	<0.3	5.2	>200	21	<0.01	ND	ND	Pass	1,070	78	18	See Report
Area 4	<1	<0.3	5.8	>200	493	<0.01	ND	ND	Pass	2,800	85	13	See Report
Area 5 *	<1	<0.3	5.0	>200	NA	NA	12.8	16	Pass	1,850	71	18	See Report
TSCA Soils	<1	<0.3	5.6	>200	33	<0.01	ND	31	Pass	1,460	83	14	See Report

Notes:

* - Soils in Area 5 were characterized by samples collected from Debris Piles 6 and 7. Soil from debris piles 6, 7, 9, 13, and 15 was composited to characterize Debris Soil B.

Results in this table are for the composite Debris Soil B sample.

NA - Not analyzed

Table 4-3
Excavation Summary

Original Location	Volume Excavated	Date Excavated
Area 1	20 cyd	9/26/94
Area 2A	25 cyd	9/26/94
Area 2B	12 cyd	9/26/94
Area 2C	660 cyd	9/22 - 10/10/94
Area 3	125 cyd	9/22 - 10/10/94
Area 4	30 cyd	9/22 - 10/10/94
Area 5	240 cyd	9/22 - 10/10/94
Debris Pile 1	20 cyd	9/30/94
Debris Pile 2	10 cyd	9/30/94
Debris Pile 3	10 cyd	9/30/94
Debris Pile 4	5 cyd	9/30/94
Debris Pile 5	30 cyd (1)	9/30/94
Debris Pile 5	60 cyd	11/17/94
Debris Pile 7	5 cyd (1)	9/30/94
Debris Pile 7	20 cyd	11/4/94
Debris Pile 15	10 cyd (1)	9/30/94
Debris Pile 15	15 cyd (2)	11/4/94
Debris Pile 15	15 cyd	12/15/94
Debris Pile G	20 cyd (3)	11/7/94

(1) Compliance samples collected at Debris Piles 5, 7, 15, and G exceeded cleanup criteria for mixed-contaminant soil and were re-excavated.

(2) The second compliance sample collected at Debris Pile 15 exceeded clean up criteria for mixed-contaminant soils and was re-excavated.

(3) The first compliance sample for Debris Pile G was taken prior to removing any soil and exceeded cleanup criteria for mixed-contaminant soil.

4.4 Transportation and Disposal

Transportation services were performed by Franklin Environmental Services Inc., of Wrentham, Massachusetts. The mixed-contaminant soil was transported to Giant Resource Recovery of Harleyville, South Carolina beginning October 4, 1994. A total of 80 dump trailer trucks carrying 1,810.23 tons were sent to Giant. Trucks were decontaminated and visually inspected for contamination prior to leaving the site. This waste stream was transported as a non-hazardous waste. The soil was incinerated in a cement kiln and recycled into cement. A shipping summary table and certificates of reuse are included in Appendix P.

On October 10, 1994 two dump trailer trucks carrying 43.40 tons of mixed-contaminant soils with PCBs greater than 50 mg/Kg (TSCA Soils) were shipped to Aptus, Inc. of Coffeyville, Kansas. This waste stream was transported using a hazardous waste manifest. This soil was incinerated in the Aptus TSCA-permitted incinerator. Copies of the manifests and certificates of disposal are included in Appendix Q.

Giant accepted mixed-contaminant soil screened of all material larger than 2 inches in diameter. The tailings from the screening operations and all stumps generated from clearing activities were sent to Envirosafe Services located in Oregon, Ohio as debris (refer to Section 2.0). A total of 16 trucks carried 352.10 tons of tree stumps and tailings. This waste stream was transported under a hazardous waste manifest. Copies of the hazardous waste manifests and Certificates of Disposal are included in Appendix R.

4.5 Compliance Sampling

The determination of the number and locations of compliance samples was originally presented in the 100% Design Report Mixed-Contaminant Soils (RETEC, 1994) and is included in Appendix S. Mixed-contaminant soil compliance samples were collected on October 4 and 11, 1994. A surveyor field-located the randomly determined sample coordinates. The sample locations are presented in Figure 4-1. The samples were collected from 0-2 feet using a hand auger. The samples were analyzed for mixed-contaminants. Twenty percent of the samples were also analyzed for the full TCL/TAL list. The compliance sample results were then statistically analyzed. The statistical analysis and summaries of the analytical results are included in Appendix T. The results of the mixed-contaminant soil compliance samples are summarized in Table 4-4. CLP data packages are included in Appendix V.

TABLE 4-4
Mixed Contaminants (mg/Kg)
Compliance Sample Summary

		Area 1			Area 2					
Compound	Target oncentratio	MS-1A 10/04/94	MS-1B 10/04/94	MS-1C 10/04/94	MS-2A 10/04/94	MS-2B 10/04/94	MS-2C 10/04/94	MS-2D 10/04/94	MS-2E 10/04/94	MS-2F 10/11/94
Lead	640	6.4	12.2	2.4	5.9	6.7	6.1	4.4	212	6.1
Chlordane	6.14	0.004	0.005	0.001	0.017	0.004	0.003	0.003	0.143	0.004
4, 4 - DDT	23.5	0.004	0.005	0.004	0.004	0.004	0.003	0.003	0.209	0.003
cPAHs	0.69	0.268	0.395	0.286	0.284	0.276	0.251	0.271	0.283	0.256
PCBs	1.04	0.049	0.109	0.052	0.735	0.300	0.274	0.272	0.177	0.269
STATUS		pass	pass	pass	pass	pass	pass	pass	pass	pass

		Area 3		Area 4			Area 5			
Compound	Target oncentratio	MS-3A 10/11/94	MS-3B 10/11/94	MS-4A 10/04/94	MS-4B 10/04/94	MS-4C 10/04/94	MS-5A 10/11/94	MS-5B 10/11/94	Standard Deveation	Mean Concentra
Lead	640	6.5	6.5	6.0	6.5	2.1	6.6	6.3	52.1	18.9
Chlordane	6.14	0.009	0.004	0.002	0.004	0.003	0.046	0.28	0.075	0.033
4, 4 - DDT	23.5	0.002	0.004	0.003	0.004	0.003	0.007	0.003	0.052	0.017
cPAHs	0.69	0.264	0.273	0.253	0.268	0.257	0.273	0.262	0.040	0.276
PCBs	1.04	0.289	0.297	0.273	0.291	0.279	0.295	0.284	0.155	0.265
STATUS		pass	pass	pass	pass	pass	pass	pass	pass	pass

4.6 Restoration

Restoration activities began on October 18, 1994. All mixed-contaminant soil areas, except Area 1 were backfilled with subsoil to bring the excavations to within one foot of the original grade. All subsoil backfill was supplied by Benevento Sand and Gravel Company of North Wilmington, Massachusetts.

After backfilling the excavations to within one foot of grade using subsoil the remainder of the excavations were backfilled with fine sandy loam topsoil. Topsoil was supplied by both Dexter and Harpell Loam, Inc., of Acton, Massachusetts, and Benevento Sand and Gravel Company of North Wilmington, Massachusetts. Area 1 was located within a wetland. This excavation was backfilled exclusively with a silt loam topsoil high in organic matter. This material was supplied by Dexter and Harpell Loam, Inc.

Excavations into the access road were backfilled with subsoil. A coarser material was used on the top four inches of the road to facilitate compaction. The subsoil and topsoil were compacted with a bulldozer. One foot lifts of soil were spread then compacted by the weight of the bulldozer. After spreading the topsoil the excavation areas were reseeded using reclamation seed mixture (see Section 3.6).

As part of restoration activities an on going monitoring program is being performed as described in the monitoring plan originally presented in Appendix K of the "100% Design Report Mixed-Contaminant Soils" (RETEC, 1994). The site engineer will continue to monitor the progress of the reseeded vegetation and look for signs of differential settling. Any differential settling will be restored by importing appropriate fill material, regrading, additional compaction, and seeding as necessary.

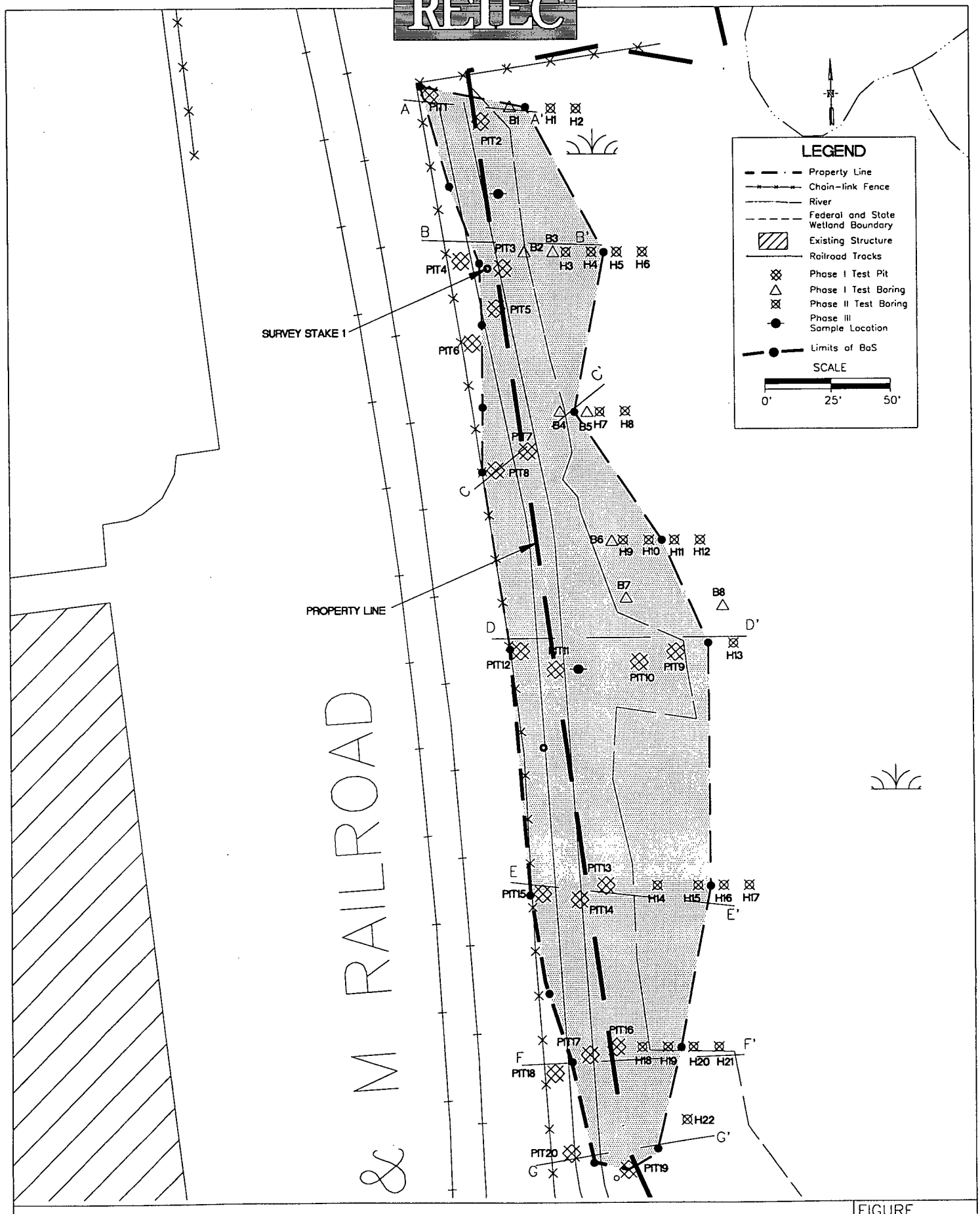
5.0 BARIUM IMPACTED SOIL INVESTIGATION

During predesign investigation activities, RETEC conducted an investigation to delineate newly discovered sludges and any undiscovered sludges in the Wildwood property. This investigation, conducted in November 1992, included excavating test trenches every 25 feet along the access road. During this investigation, a white powdery substance was observed within the soil matrix in the northern portion of the Wildwood property. This material was observed along the northern portion of the access road and the sewer rights-of-way. A sample of this material was sent to New England Testing Laboratory, Inc. (NETL) to determine the chemical characteristics of the material. The initial results indicated that the suspect material contained barium, sulfur and silica. The material was also found to contain hydrogen sulfide. As a result of this discovery, three phases of investigation were performed to determine the nature of the material and delineate it in the field. Further details regarding the investigation and the results are presented in Appendix U.

5.1 Nature and Extent

Figure 5-1 presents the limits of barium impacted soil east and south of the northwestern property boundary. No exploration was conducted outside of the Wildwood property and City of Woburn boundaries.

The stratigraphy of the barium impacted soils generally consisted of a six-inch to one-foot layer of brown sand or sandy silt over a six-inch to two-foot layer of soil with barium powder within the soil matrix. A wet, dark brown to black organic peat was encountered under the layer of soil and barium powder. Figure 5-2 presents cross-sections of the barium impacted soils area along with the Phase I and Phase II composite sample locations. Figure 5-2 also shows the approximate locations of the MWRA and City of Woburn sewer easements. This figure shows a distinct layer of soil and barium powder within the soil matrix over the sewer easements which tapers off east and west of the easements. The volume of soil containing barium powder is estimated at 1,100 cubic yards. This volume is based upon the horizontal and vertical limits identified during the supplemental sludge investigation.



LIMITS OF BARIUM SOIL

FIGURE
5-1
WILDW3.DWG

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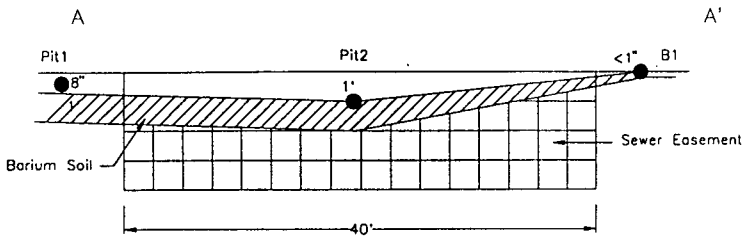

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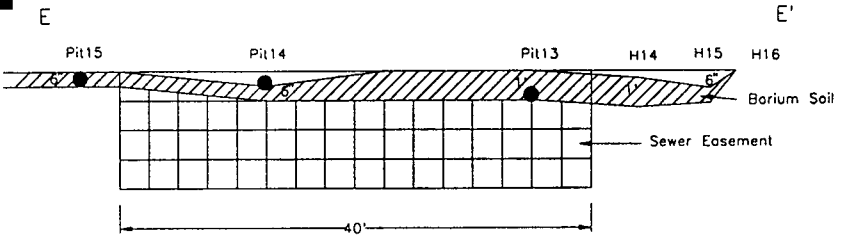

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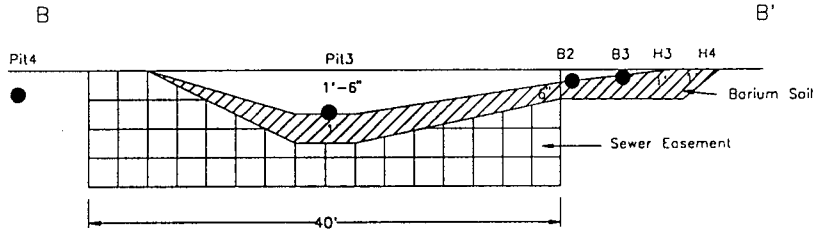
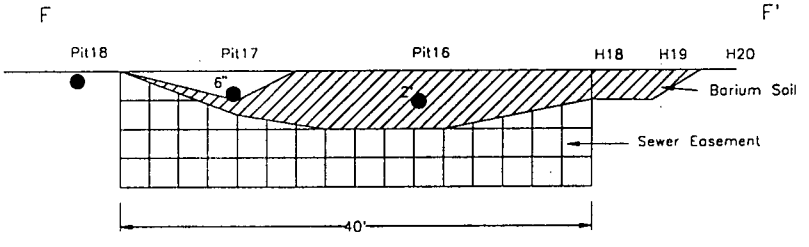


X-SECTION B-B'



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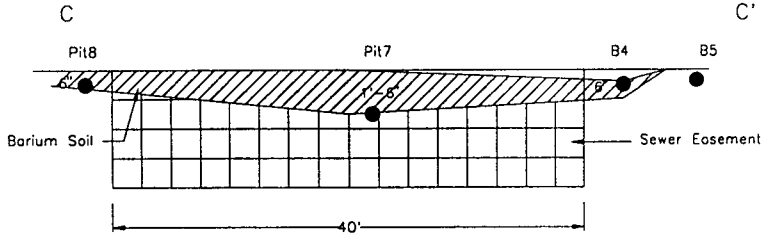

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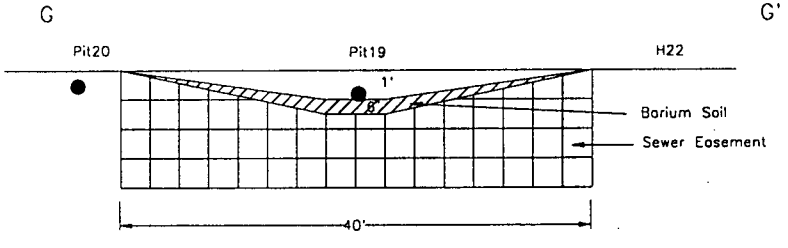

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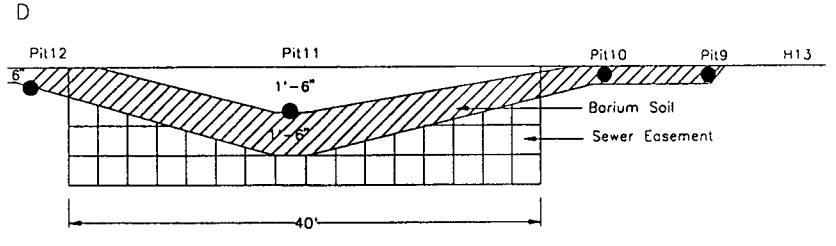

X-SECTION D-D'

Note: Figure not to scale

WILDWOOD
CROSS SECTIONS OF BARIUM SOIL

FIGURE
5-2
0947X010

The original chemical characterization of the barium impacted soil during the Wildwood property predesign investigation (RETEC, 1992) identified the material as being largely composed of barium, sulfur, and rock-forming minerals common to native soils. Laboratory analyses performed on samples of the material indicated that the barium impacted soil is not a hazardous waste. However, levels of sulfide reactivity ranging from below detection limits to 407 mg/Kg were observed in samples collected during subsequent investigations.

A sample collected during the Phase III investigation contained total barium at a concentration of 7,120 mg/Kg, while the TCLP extractable sulfide and total sulfide concentrations were below their respective quantification limits. In contrast, both the TCLP extractable sulfate and total sulfate analyses indicated the presence of sulfates. These results confirm that barium sulfate is present in the material. Upon exposure to air and water, barium sulfide tends to oxidize in dry air and slowly decompose in damp air into carbonate and other compounds (Merck, 1989). In solution, barium sulfide will decompose and combine with sulfate to form barium sulfate (EPA, 1985). The analytical results suggest that the predominant barium compound at the site is probably barium sulfate and is not sulfide reactive.

5.2 Toxicity Evaluation and Calculation of Cleanup Standards

A review of toxicity studies involving barium is presented in Appendix U. The Endangerment Assessment (Clement, 1988) indicated that the potential adverse effects in humans following oral exposure to barium were associated with soluble barium compounds. Insoluble forms of barium, particularly barium sulfate, are not toxic by ingestion or inhalation because only minimal amounts are absorbed (EPA, 1985). Therefore, a summary of the solubilities of various forms of barium provides a simple means of evaluating their relative potential toxicity to humans. Of the various barium compounds, barium chloride is considered very soluble in water, barium sulfide is slightly soluble, barium carbonate is almost insoluble, and barium sulfate is practically insoluble in water (Merck, 1989).

There are currently no barium ambient water quality criteria for aquatic organisms. It is generally believed that the physical and chemical properties of barium will preclude the existence of toxic soluble forms under usual marine and fresh water conditions and thus a restrictive criterion for aquatic life is considered unwarranted (IRIS, 1994).

The same methodology and exposure assumptions used in the Endangerment Assessment (Clement, 1988), for ingestion and dermal contact scenarios were used to calculate a concentration

of barium that would result in a hazard index of 1 for an intake equal to the reference dose. A conservative oral reference dose for barium of 0.05 mg/Kg-day was used in the calculations. These calculations are presented in Appendix U. The most conservative cleanup level calculated for barium was 48,884 mg/Kg-soil. This cleanup level was calculated for a plausible maximum exposure of a young male adult resulting from ingestion and dermal exposure of impacted soil. It should be noted that the cleanup level represents health-based concentrations for soluble barium compounds. The barium found on the Wildwood property is composed largely of non-soluble barium that is considered non-toxic in soil.

The methodology used to calculate health-based cleanup levels for the various receptor groups was based on the very conservative assumption that all of the barium powder at the site is composed of pure barium sulfide, even though there is evidence that suggests that the predominant barium compound present is probably barium sulfate.

As previously discussed, there is currently no direct means of determining the concentration of the various barium compounds present at the site. However, the reactivity sulfide data, summarized in Appendix U, could be used to provide an approximate means of determining the amount of barium sulfide present at the site. For example, the highest concentration of reactive sulfide detected was 407 mg/Kg in sample # 2. The actual concentration of barium sulfide present in this sample may be as high as 1,000 mg/Kg. This is due in part to the tendency of barium sulfide to rapidly form barium sulfate in an aqueous solution. Since the assumed maximum detected concentration of barium sulfide is 49 times less than the most stringent health-based cleanup level, it is reasonable to conclude that the barium powder present at the site does not pose a threat to human health via ingestion or contact.

A review of the groundwater monitoring data collected in September 1992 indicates that barium is not present in elevated concentrations in groundwater at the Wildwood property. Barium is not soluble at more than a few parts per million in water that contains sulfate at more than a few parts per million (EPA, 1985). The highest concentration of barium, observed during this sampling event, was 0.0659 mg/L in Well S-88M. In contrast, the Maximum Contaminant Level (MCL) for barium is 2 mg/L. This comparison indicates that the barium powder is not a threat to human health via the groundwater pathway.

In conclusion, it is reasonable to conclude that the barium impacted soil found at the Wildwood property does not pose a threat to human health and may be left in place.

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